

**United States Coast Guard  
Shipboard Technology Evaluation (STEP) Program  
For Experimental Ballast Water Treatment Systems**

**2004**

**APPLICATION REQUIREMENTS**

**INFORMATION FOR THE APPLICANT**

The United States Coast Guard Shipboard Technology Evaluation Program (STEP) for onboard ballast water treatment systems is designed to provide incentive to ship owners and operators to install experimental or prototype treatment systems with demonstrated potential for effective removal or destruction of unwanted organisms in ballast water. The U. S. Coast Guard (Coast Guard) and the successful Applicant enter into an agreement whereby valuable experimental data accrues to the Government and the public at large and the Applicant's vessel is accepted into the STEP for a specific period of time, during which operation of the experimental system is considered equivalent to meeting applicable regulatory requirements for ballast water management. The regulatory nature of the terms of the agreement therefore require that the application meet a detailed set of specifications to enable a thorough evaluation prior to acceptance.

The general expectations of the Coast Guard are for well conceived experimental designs and proper testing protocols. Acceptance into STEP results in a designation of equivalency to future ballast water discharge standard regulations, for up to the life of the vessel or the system, while the prototype system operates satisfactorily. The main points of your program must address the testing and monitoring provisions outlined in the Coast Guard's *Navigation and Vessel Inspection Circular NVIC 01-04 "Shipboard Technology Evaluation Program (STEP): Experimental Ballast Water Treatment Systems"*. The test design must include comparisons of treatment system performance with that of ballast water exchange (BWE) on your ship(s) and your experiments must specifically address the mortality and/or viability of the wide variety of organisms present in ballast water. In addition, the terms of acceptance require that the Applicant operate the system as designed throughout the equivalency period maintain the system to ensure reliable operation, monitor system performance, and submit quarterly and annual reports on operations and performance.

Participation in the STEP requires first that the Applicant follow several steps in a process whose particulars are available in this and the accompanying documents (Appendix). Further assistance is available from the Coast Guard's Environmental Standards Division (G-MSO-4).

**Review Panel**

The Volpe National Transportation Systems Center (Volpe Center) is an agency of the U.S. Department of Transportation without regulatory or enforcement authority, and acts as the Coast Guard's agent in this matter. The Volpe Center manages and executes a Review Panel, the work of which includes:

- Technical evaluation of the applications;

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- Observation of the experimental test program in Years 1 and 5 of the equivalency period; and
- Review of the Applicants' reports on the monitoring of the treatment system's operation and performance.

The findings and recommendations of the Review Panel will, in part, be the basis of the Coast Guard's decisions on acceptance into the STEP and compliance.

### Process

The submittal of your STEP application to the Coast Guard must include a Letter of Commitment, a detailed study plan, and the required supporting documentation.

**Potential applicants should review carefully the document "Background Information for Applicants" for additional information about preparing application packages.**

The Review Panel will conduct an initial check to see whether all the required elements of the application have been completed; and send you a Notice of Completeness. This Notice will, if necessary, identify and explain any deficiencies of your application. Such deficiencies may then be addressed, and the application may be resubmitted without prejudice. However, resubmitted applications will be considered as new applications, except in case where minor omissions only require rectification. In such cases, the Applicant may amend the application and return it promptly without losing his place in the administrative queue.

Once the application is deemed complete, the next, more detailed and technical, phase of the review begins. The Review Panel will assess all aspects of the study plan and its supporting documentation and may request clarifications and additional information through a Questionnaire tailored to the treatment system technology and experimental test program. The Questionnaire follows the same logic and organization as the study plan format included herein (as does the Notice of Completeness), and will be prepared such that the Applicant will not have to repeat the submittal of all the data and information contained in the study plan. It will, in short, be a follow up inquiry meant to complete the Review Panel's acquisition of system and test program particulars.

The Review Panel's work continues following the decision of the Coast Guard to accept the vessel into the STEP. The Panel's evaluation of compliance with the study plan and system operation will continue throughout the experimental phase (Years 1 - 5) of the equivalency period, through review of reports submitted by the Applicant. The Panel will function similarly in tracking of the system's engineering and treatment performance during the monitoring phase (Years 6 and onward), and onboard inspections may be carried out by the Coast Guard as part of routine and non-routine vessel inspections.

The Review Panel will request one or more site visits:

- Scoping visit to the ship following installation and engineering testing of the treatment system and before the start of the experimental program;
- One visit to the ship during the primary experimental test program; and
- One or more follow up visits in subsequent years for monitoring of operational and environmental performance of the system, including the Year 5 repetition of primary testing.

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A flow chart with a generic timeline is included in this package to help illustrate the process.

### **Significant System Modifications**

The Applicant must report any significant modifications to the system's design or operations, whether during the initial review process, or during the period of equivalency. Such an event may require additional assessment by the Review Panel, and a decision by the Coast Guard on the need for revisions of the test and monitoring compliance plans, reinterpretation or rework of supporting experimental programs, and review of any required environmental permits. If the system modification(s) require such action, the timeline for Government action on the application may be extended accordingly.

### **Primary Requirements of Application**

1. Letter of Commitment from the ship owner, indicating the identity and roles of the ship operator, the treatment system manufacturer and developer, and the test team
2. Environmental compliance documentation
3. Documentation of preliminary experiments demonstrating efficacy of the Applicant's treatment system
4. Study Plan

Note: The Volpe Center requests that submissions of technical documentation, e.g., the Study Plan, be made in electronic format, to the greatest extent possible. However, for engineering drawings, large format prints are preferred.

### **1.0 Letter of Commitment**

A Letter of Commitment must be prepared by the ship owner, indicating the identities and roles of the ship operator (if different than owner), the manufacturer or developer of the treatment system if involved in the project, and the principal investigators conducting the tests, stating their intents to carry out all components of the study plan for which they are responsible. The Letter must be submitted with the Application Package.

The Government does not specify the form of the Commitment Letter.

### **2.0 Environmental Compliance**

#### ***2.1 Conditioning of Treated Water Prior to Discharge, and Assessment of Discharged Water***

The Applicant must describe the effect of treatment on the ship's ballast water, in particular the nature of any treatment residuals and byproducts and the water's suitability for discharge into coastal waters. Describe any actions necessary to "condition" and monitor treated water in order that it meet applicable water quality regulations prior to discharge.

#### ***2.2 Management of Treatment Waste Streams***

The Applicant must identify and characterize any treatment system sidestreams (e.g., filtered material, centrifugal concentrate, waste or residual chemicals) and describe actions planned to properly manage and dispose of such waste.

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### ***2.3 Literature Search***

The Applicant must provide the results of a literature search of published, peer-reviewed or 'gray literature' articles that address the potential environmental impacts of the proposed technologies. The literature search should address, but not be limited to, impacts to threatened or endangered species and critical habitat. The literature search should reflect uses of the technologies beyond shipboard applications, to include industrial and water treatment applications.

### ***2.4 Documentation***

The Applicant must provide documentation stating there will be no use or production of any regulated substances, or that the residual concentrations of any treatment chemicals or chemicals that occur as disinfection by-products meet all applicable local, state, federal, and tribal requirements. The application must contain copies of permits, approvals, or waivers from the applicable jurisdictions for the discharge of effluent from the treatment system.

## **3.0 Documentation of Prior Experiments Demonstrating Efficacy of the Applicant's Treatment System**

The documentation for each experiment must include particulars similar to those listed below for the onboard study plan, i.e., schematic and description of the treatment system, experimental design and test protocol documentation, and identification of the principal investigator and other key persons. The Review Panel will also expect to see descriptions of process testing methods and conditions, and discussions of similarities and differences to the proposed onboard treatment system. The Applicant should also address scalability issues and the functioning of the treatment system in the ship's operational environment.

One qualification for acceptance is that preliminary results must indicate that the treatment process, as tested, is capable of removing or killing at least 98% of organisms larger than 50 microns from source waters generally similar to ballast water in biological and chemical characteristics.

### ***3.1 Laboratory Experiments (bench scale)***

### ***3.2 Shore Side Experiments (intermediate scale)***

### ***3.3 On Board Experiments (intermediate or full scale)***

### ***3.4 Data Submission Requirements***

The Applicant shall submit all relevant data relating to each experiment, including the raw data, analytical methods employed, measures of confidence and deviation, and interpretation of results. The application should present data and interpretations so as to provide system performance information, as a function of state variables such as concentration of biota, turbidity, salinity, temp, etc.

Experimental results should be expressed as concentrations of organisms in treatment and control samples, in addition to expression as the percent difference between treated and untreated samples.

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The ship-board experiments should test the hypothesis that the same level of treatment seen in prior experiments would be achieved on ship under the similar set of state variables.

## **4.0 Study Plan**

### ***4.1 Format Requirements***

The application must first and foremost address all the points of this document, and do so according to the logic and numbering herein. Any reference to other technical documents must be clearly explained and fully cited (e.g., page and figure numbers) in the application, and the reference materials must be included (e.g., drawings, vendor information, relevant sections of scientific books or papers). References and appendices may not substitute for clear explanation in the body of the application.

### ***4.2 Test Organization and Staff***

Overview of team structure and management, including clear delineations of authority and responsibility (e.g., owner representative, test director). An organizational chart is required, as well as the identity of all key test team personnel and their organizations (including test director and other managers, technical staff, and support organization project leaders). The role of each in the development and execution of the test must be clear.

#### ***4.2.1 Ship Owner and Operator***

Provide the name of line and ship, owner identity and address, name and contact information for person serving as point of contact for the vessel owner, charter type and duration, key shipboard personnel, particularly engineering staff if practicable.

#### ***4.2.2 System Vendor(s)***

For each company, provide the company name, location, relevant component, name and contact information of person acting as point of contact (if any) for vendor, and field service representative(s) involved with test.

#### ***4.2.3 Test Team and Affiliations***

##### ***4.2.3.1 Management***

##### ***4.2.3.2 Technical staff***

Identify all key personnel, and provide a description of qualifications.

##### ***4.2.3.3 Laboratories***

Identify by name, location, and affiliations with industry, academia, and government. Briefly describe the relevant capabilities and certifications for each laboratory.

#### ***4.2.4 Testing Flow Chart***

This chart tracks sampling, analysis, and data synthesis responsibilities. Its purpose is to show the transport and processing of samples in a chart so that the sites of sampling, number of reps, sample splits, etc. can be seen at a glance. A sample is appended.

#### ***4.2.5 Public Funding Sources***

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Identify public funding, if any, including sources, amounts, and key performance requirements such as schedule, design and protocol specifications, and reporting.

### ***4.3 Description of Vessel and Ballast Water Treatment System***

#### ***4.3.1 Test Ship, Location, and Conditions***

Provide ship name, identification number (IMO number and, if applicable, Coast Guard vessel identification number (VIN)), type/size/build year/general arrangements, route(s), home port, flag state, classification society, nationalities of officers and crew (particularly engineering staff), characterization of local waters at both intake and discharge points for ballast water (only to the extent allowed by the nature of your ship's operating characteristics). Describe existing ballasting/deballasting system. Identify and describe all connections between ballast system and other compartments such as black and grey water storage. Identify capacities of all ballast tanks, and typical volumes discharged (to the extent practicable). Identify and describe all compartments involved in any aspect of testing, including location of treatment system, ballast tank(s) and cargo hold(s) to be tested, and other compartments used for laboratory procedures, storage of equipment and materials, and administrative tasks. Describe arrangements for shipping of samples.

#### ***4.3.2 Treatment System Overview***

Describe location and arrangement of treatment system and its integration with existing equipment, all relevant piping modifications, system start-up and operating procedures. The following section (4.3.3) requires detailed descriptions of individual components; the overview should provide an overall system description and specify individual components in terms only .

#### ***4.3.3 Treatment Stages***

Describe principles of operation, unit construction, materials and standards, performance specifications and limitations, and the expectations of performance for each treatment component.

##### ***4.3.3.1 Stage #1***

##### ***4.3.3.2 Stage #2***

##### ***4.3.3.3 Stage #3 (continue as necessary)***

#### ***4.3.4 Powering and Other Engineering Matters***

#### ***4.3.5 Controls and Monitoring***

### ***4.4 Experimental Design and Protocols***

#### ***4.4.1 General Description***

State the experimental hypotheses and important descriptors of the primary experimental test, including kill method, target taxa (biota, life stages, and physiological state), methods for determination of removal, mortality, or viability, and reasons for choosing them. The Applicant should identify the test location, source waters, and environmental factors, to the extent possible allowing for the ship's service characteristics. The overall study plan should take full advantage of the range of locations provided by the vessel's operations, to the extent practicable.

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The plan must also state the approach to testing the treatment system's effectiveness and comparing it to that of ballast water exchange. Include specifics of the experimental design's accommodations for the particulars of the test bed (e.g., isolating effects of onboard machinery and accounting for biological conditions in the ship's ballast tanks and piping) and the particulars of the ship's ballasting system, as well as the *type of* statistical experimental design used in testing. The design must address the operations of all ship's systems whose arrangements (e.g., cross connections and other tie-ins) have the potential to cause contamination of the ballast water or otherwise confound the resulting data.

The plan must include both "primary experimental tests" and "performance monitoring". Primary testing will comprehensively measure system performance and will begin during the first year after installation and acceptance of the test plan. The aim of performance monitoring is to ensure consistent performance while the vessel's equivalency is in force, through a regime of periodic, limited sampling and analysis. The equivalency period includes the "experimental phase" of Years 1 – 5, and the monitoring phase after Year 5. Performance monitoring is required during both phases and is addressed in section 4.7.

The primary test will be repeated during the fifth year of the equivalency period. The purpose is to establish an estimate of system efficacy for comparison with the results observed in the first year. For continued participation in the STEP following the experimental period, the biological efficacy of the system during the final primary experiment in Year 5 must at least meet 90% of the average of the efficacies observed during the initial primary experiments.

In addition to the Year 1 and Year 5 iterations, the primary test may also need to be repeated if the system is used to treat new ballast source waters where the system's effectiveness has not been previously assessed, if the biological and physical characteristics of the new source water are substantially different than those in prior tests.

#### 4.4.2 *Goals for Treatment Effectiveness by Target Taxa*

##### 4.4.2.1 Treatment effectiveness on target taxa

List the expected treatment effectiveness by taxa and specific species and resting stages, where applicable, including:

- Nekton
- Zooplankton
- Heterotrophic and autotrophic protists
- Phytoplankton
- Viruses and Bacteria
- Other

##### 4.4.2.2 Comparison with ballast water exchange effectiveness

Provide information on the use of ballast water exchange on your type of ship, that is the operational method of exchange and its past use on this ship. If available, provide information on the effectiveness of exchange with regard to nekton, zooplankton, phytoplankton, viruses and bacteria, and other organisms.

#### 4.4.3 *Experimental Design*

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#### **4.4.3.1 Sample collection for each treatment and control.**

Provide chart or flow diagram outlining the treatments and controls, identification and number of replicate tanks, samples and time points encompassed in a test.

#### **4.4.3.2 Description of the number of test runs.**

Describe replicate tests (tests at same location and environmental conditions) and comparative tests (tests at different locations or environmental conditions). The tests should take advantage of the vessel's operations and itinerary and should be run in at least two different locations.

The plan should address statistical analysis (including power analysis) and data confidence issues, and should also address investigating the statistical correlation between primary and performance tests.

#### **4.4.3.3 Range of operational and environmental conditions**

To the extent possible, describe the range of seasons, organic matter content, turbidity, pH, salinity, etc. likely to be encountered in operation and how the experiment accounts for these variables. Address the possibility that any of the anticipated conditions could hamper proper operation of the treatment system.

#### **4.4.3.4 Measurement of treatment system and ballast water exchange performance**

Fully describe the intended statistical tests, use of controls, and replicates for each target taxa.

#### **4.4.3.5 Experimental comparison of treatment system to BWE**

Describe how the efficacy of the treatment process will be compared experimentally with the effectiveness of ballast water exchange, which works primarily by replacing coastal organisms with mid-ocean organisms; include a description of how the % replacement of coastal water by mid-ocean water will be quantified, as well as a description of the comparison of biological efficacies.

#### **4.4.3.6 Reporting procedures**

Describe the schedule and outline of the report on the experimental program. It is important to include procedures for data storage, data analysis, instrumentation maintenance and calibration records, and quality assurance information.

### ***4.4.4 Sample Collection and Analytical Protocols, Including Standard Operating Procedures***

#### **4.4.4.1 Sample collection and handling.**

Detail the sampling gear, including any modifications made to the ballast system to permit sampling, cleaning and maintenance procedures, sample storage and transport, subsampling/splitting procedures, etc.

#### **4.4.4.2 Laboratory/field measurement procedures**

Describe analytical procedures for chemical and biological assays, i.e., how mortality is to be determined.



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#### **4.4.4.3 Sample archives**

Describe the sample archiving process for storing preserved samples or sample splits for later re-examination or confirmation, if needed.

#### **4.4.5 *Quality Assurance and Control for sampling and analysis***

Provide the important elements of a QA/QC plan, including the employment of analytical duplicates, blanks, reproducibility of analytical procedures, analysis of accuracy, and precision.

#### **4.4.6 *Schedule and Milestones***

Provide at least a rough schedule for system installation, system testing, experimental test activities, and submission of reports.

#### **4.4.7 *Review Panel Observation of Primary Tests***

The Review Panel will, on at least one occasion, observe the primary tests onboard. The Applicant will ensure reliable treatment system performance and fully vetted test protocols by running at least two test iterations prior to the Review Panel visit. The Review Panel will be available to observe testing at or near ports in the mainland United States only.

#### **4.4.8 *Other measures of success***

The test team may identify other experimental or performance measures not anticipated by the Coast Guard. The experimental methods and data required should be clearly described, as for other measures specified herein.

### **4.5 *Engineering and Vessel Operations Matters***

#### **4.5.1 *Treatment System Configuration***

##### **4.5.1.1 Engineering documentation package**

Provide a coherent and integrated documentation package with an explanatory cover letter and index of enclosures, the most recent version of all drawings, and clear identification of preparers, drawing numbers, and titles.

##### **4.5.1.2 Mechanical layout drawings, PFDs, and P&IDs**

Provide engineering drawings showing existing onboard equipment arrangements, piping, and power, showing new treatment equipment and ancillary components, and identifying all involved machinery compartments, ballast tanks, cargo holds, and any other compartments affected by the treatment system or to be used by the test team for execution of any phase of the experiment. The submission should include Process Flow Diagrams (PFDs), identifying all components and streams, including all ship systems interfacing the treatment system (ballast pumps and tanks, and any other systems with cross-overs or tie-ins which could potentially affect the test results), and Piping and Instrumentation Diagrams (P&IDs) showing:

- Equipment types, sizes, ratings, materials of construction
- Valve types, sizes, materials of construction
- Line sizes, materials of construction, connection types
- Design flowrates
- Sample taps
- Instruments, control elements, interlocks, control approaches, etc.

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Also provide ballast/deballast system specifications, likely ballast loading arrangements, the procedures followed by ship's crew, and whether any procedural changes are necessitated by the use of your treatment system.

#### ***4.5.2 Ship Operations Interface and Crew Labor Impacts***

Describe the likely ballast loading arrangements, the human operational requirements for the treatment system, and the approximate burden, in man-hours, for the crew.

#### ***4.5.3 Maintenance and Reliability***

Describe the maintenance requirements of all system components, including approximate crew man-hours, and the reliability history of similar or equal components in marine or other applications.

#### ***4.5.4 Classification Society Approval***

Provide documentation that the design and installation of the treatment system has been reviewed and approved by a classification society belonging to the International Association of Classification Societies (IACS), e.g., the American Bureau of Shipping, Lloyd's Register, or Det Norske Veritas.

### ***4.6 Human Health and Safety***

The Applicant should include a health and safety plan if available.

#### ***4.6.1 Exposure to treatment system media***

Describe any potential exposure of test team or ship's crew to the active components of the treatment system, e.g., UV radiation, chemical biocide, etc. Identify planned actions for eliminating or minimizing such exposure, monitoring for such exposure, and treating such exposure.

#### ***4.6.2 Safety impacts of treatment system***

Ergonomics, escape arrangements, pumping and damage control arrangements, added weight and moment.

### ***4.7 Long Term Treatment System Performance Monitoring***

The Applicant must describe the proposed protocols for monitoring system performance throughout the equivalency period.

#### ***4.7.1 Treatment Performance***

Provide for regular monitoring of treatment system effectiveness, and an approach for comparison to the primary test results. The key to performance monitoring is to conduct less intensive tasks than in the primary test, and to establish the correlation between them. The Applicant may choose to conduct treatment performance monitoring through measurement of engineering parameters and/or a program of simplified biological testing. An effective way to establish the correlation is to run the performance monitoring tests concurrent with the first round of primary tests. Performance testing should also be capable of detecting system failures.

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If engineering performance measures are chosen, the data should be collected every time the system is operated throughout the equivalency period.

If biological testing is the chosen method of performance monitoring, it should be shown that treatment system performance remains stable for three consecutive operations following the primary experiments. If such is the case, the monitoring testing interval may be increased to once every three months. If the system performance continues to remain stable for one year, the testing may then be extended to once every four months for a year, and then to once every six months.

#### *4.7.2 Engineering Performance*

Provide a plan for equipment life cycle management (maintenance, testing, and repair through anticipated service life), to ensure reliable and consistent operation.

#### *4.7.3 Reporting Requirements*

During the experimental phase (Years 1 - 5), the Applicant is required to provide annual and quarterly reports on the monitoring of system performance, maintenance and operations issues, summary of ship's movements including changes from anticipated service, problems and system breakdowns, and health, safety, and environmental aspects. During the monitoring phase (post Year 5), the Applicant is required to provide annual reports only.

The quarterly reports should provide:

- 1) If applicable, installation progress to date, and an updated installation schedule (identify and date the major tasks, the critical path, float time, milestones, substantial completion, and final completion).
- 2) Problems with, or concerns relating to, the performance or operation of the treatment system encountered over the past quarter (include dates of system downtimes, analyses of downtime causes, descriptions of resolutions, and steps taken to prevent reoccurrences);
- 3) Changes (implemented or planned) to the treatment system, operational procedures, or experimental program (planned changes should be accompanied by justifications, and should not be implemented unless reviewed by the Review Panel and approved by the Coast Guard);
- 4) Instrument calibration logs for the past quarter;
- 5) The current contact in the organization of the Applicant overseeing the project and installation (include name, title, business address, and phone numbers); and
- 6) Emergent issues in human health and safety, and compliance with environmental laws and permits.

The Annual Reports should include:

- 1) If applicable, a summary of installation activities;
- 2) A signed statement confirming that substantial completion of the installation has been achieved (first year only);
- 3) Ship itineraries utilized for the past year and scheduled for the upcoming year (include ports visited and voyages performed with approximate dates). If

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detailed itineraries for the upcoming year are not available due to unpredictable operations, the nature of the future operations should be reported to the level of detail known (in this case, the Review Panel and the Coast Guard should consider shifting the reporting of upcoming schedules to the quarterly reports);

- 4) Locations and volumes of ballasting and deballasting operations over the past year (to be tracked in log books), and anticipated for the upcoming year (to be supported by above itineraries). As above, the Review Panel and the Coast Guard should consider shifting the forecasting of ballasting operations to the quarterly reports for ships with loosely defined schedules;
- 5) Descriptions and dates of BWT system routine maintenance performed over the past year, and planned for the upcoming year;
- 6) Invoices (with quantities) for chemicals, UV lamps and sleeves, or other items purchased over the past year for the proper operation of the treatment system (should demonstrate adequate use of the treatment system);
- 7) Anticipated quantities of chemicals, UV lamps and sleeves, or other items required during the upcoming year for the proper operation of the treatment system (include backup calculations justifying quantities);
- 8) A summary of the problems with or concerns relating to the performance or operation of the treatment system encountered and the resolutions implemented over the past year (details should have been provided in the quarterly reports);
- 9) Summary of changes (implemented or planned) to the treatment system, operational procedures, or experimental program (details should have been provided in the quarterly reports); and
- 10) Report of primary experimental and performance monitoring data, with interpretations..
- 11) Summary and synthesis of the BWT performance from the installation date, with interpretation.
- 12) Actions on, and resolution of, emergent issues in human health and safety, and compliance with environmental laws and permits.

## Appendix

### Example Testing Flow Chart

